

95

Comparison of Fluorine Levels in Crops Before and After Aluminum Factory Operations in The Dalles Area

8 E55 copy 2

S105



by
O. C. Compton
L. F. Remmert
W. M. Mellenthin

Miscellaneous Paper 95
August 1960

Agricultural Experiment Station
Oregon State College
Corvallis



Comparison of Fluorine Levels in Crops Before and After
Aluminum Factory Operations in The Dalles Area

by

O. C. Compton, L. F. Remmert, and W. M. Mellenthin*

Summary

The fluorine content of seven crops grown in The Dalles fruit area have been studied beginning in August, 1953. Determinations of leaf fluorine have been made four times previous to and three times since July 26, 1958, the date when a local aluminum reduction factory started operations. Crops sampled were in Oregon, within 6 miles of the factory. A summary of these data are presented in Table 15, page 27.

Leaf samples taken before July 26, 1958 averaged less than 12 parts per million (ppm) fluorine at each collection. Similar samples collected October 7, 1958, 73 days after start of operation of the factory, ranged from 16 to 197 ppm, averaging 68 ppm fluorine. In 1959 the June 17 samples ranged from 6 to 106 ppm, averaging 26 ppm fluorine while those collected August 27-28 ranged from 18 to 207 ppm, averaging 73 ppm fluorine.

The fluorine content of samples taken October 7, 1958 decreased from an average of 140 ppm at 1 mile from the factory to an average of 54 ppm, 4-5 miles away. Results obtained in 1959 were somewhat similar.

Fluorine burn on leaves was not found in 1953, 1957, and 1958 but was severe in 1959 on certain apricot and prune trees growing within 2 miles from the factory. There was a wide variation in the degree of burn from tree to tree within an orchard.

Premature ripening and softening at the suture of Red Haven, J. H. Hale and Elberta peach fruits occurred in certain orchards in 1959. This condition had not been observed previously in this area.

* Horticulturist, Chemist, and Superintendent, Mid-Columbia Branch Experiment Station, respectively, Oregon Agricultural Experiment Station.

Introduction

Previous studies (3, 4, 7) have indicated that aluminum reduction factories emit fluorides into the atmosphere. These emissions may be in quantities harmful to crops grown nearby.

When it appeared that an aluminum factory was to be constructed in The Dalles area, it seemed advisable to determine the fluoride content in forages and in foliage of crops grown there prior to operation of the factory. This information, supplemented by similar determinations after the factory began operation, would be an aid in evaluating the degree and extent of a possible accumulation of airborne fluorides by these crops as a result of factory operations. Fluorine data for both periods are included in this report.

Methods

Plant sampling sites were selected at approximately 1-mile intervals in each of several small valleys that dissect the orcharding area to the east, south, and west of The Dalles. The distribution of these sites is shown on the map in Fig. 1. To the extent possible, leaf or forage samples were collected from certain crops grown at each site. Because of the variation in the crops grown from farm to farm, no single crop was sampled at all the sites selected. Sweet cherry was the most common crop. The other crops were sour cherry, peach, apricot, alfalfa, prune and grape. Nineteen sites were selected in 1953, from which 53 samples were collected. No samples were collected in 1954, 1955, and 1956. In 1957, 41 sampling sites were selected, including most of those used in 1953. Ten representative trees of each fruit crop at each orchard were selected, labeled, and used for all subsequent sampling. Alfalfa fields were sampled by collecting 10 to 15 small portions at random over an area representative of the field and compositing these portions into a single sample. Samples were collected twice a year between June and October in 1957, 1958 and 1959.

Leaves of trees and grape vines were taken from the mid portion of the shoots or canes while the alfalfa included all the stem to within 3-4 inches of the ground.

Peach fruits were sampled in 1959 only, fruit being collected from five orchards. Wedge shaped portions of the flesh were cut from the suture and from the side opposite the suture and analyzed separately.

Samples similar to those from The Dalles were collected at Corvallis or Hood River for controls or checks.

All samples were treated with lime after mixing or chopping and placing in large cellophane bags. Their fluorine contents were determined by the method reported by Remmert and Parks (5).

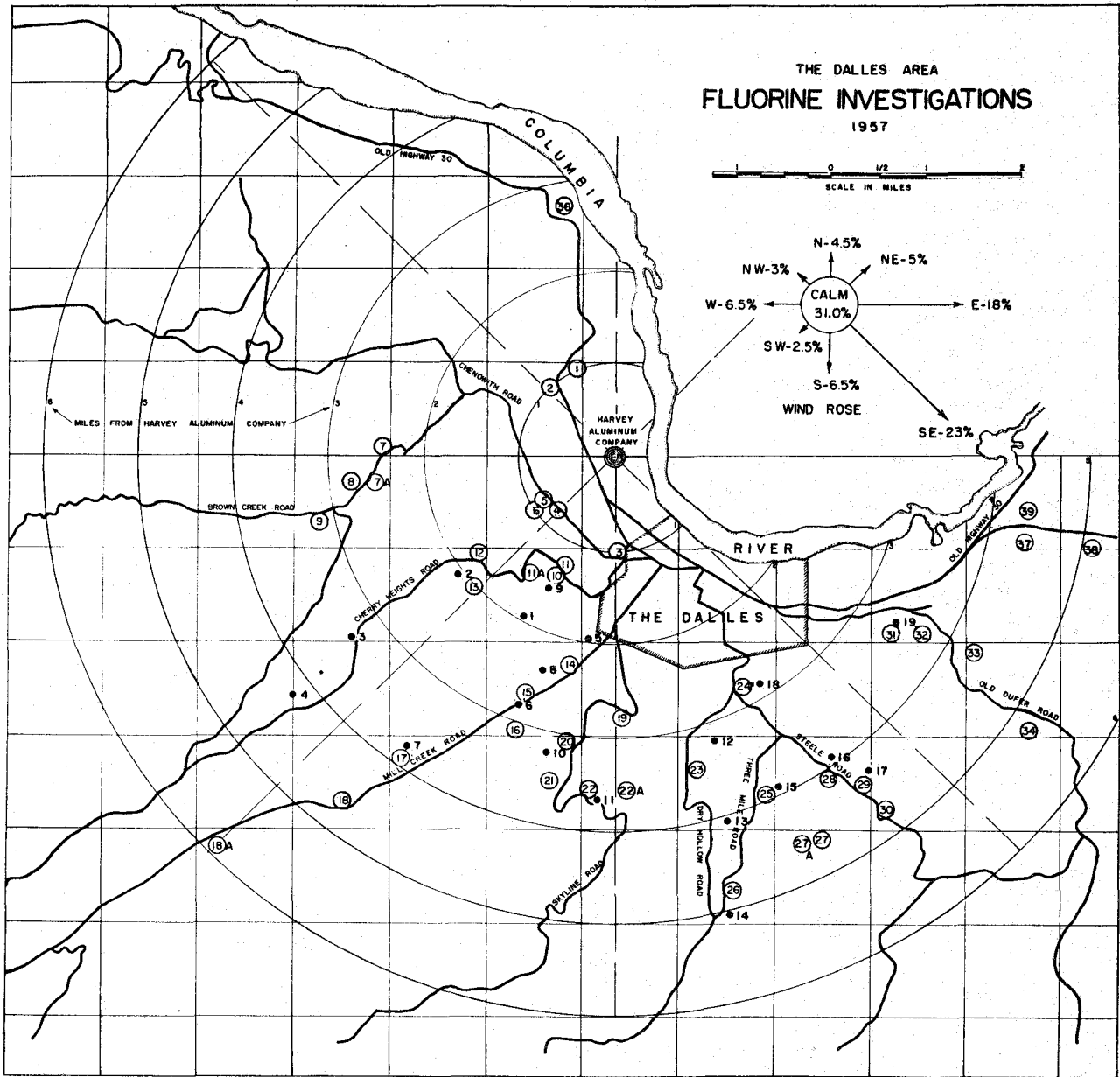


Fig. 1. Map of sampling locations. Solid dots represent 1953 sampling locations. Those with numbers in circles represent sampling locations after 1953.

Results

1953 Data

The fluorine content of the various samples taken in 1953 are presented in Table 1 and summarized in Table 2. Locations of the sampling stations are shown in Fig. 1. The average fluorine content for the several crops ranged from 4.0 ppm for prunes to 7.9 ppm for sweet cherries. The range for all samples was from 1.2 ppm to 16.8 ppm, averaging 6.4 ppm. Only eight of the 53 samples contained over 10.0 ppm, five of these being cherry samples. These values are of the same magnitude as those found previously for similar plant materials grown in the Willamette Valley in areas free of known sources of airborne fluorides.

1957 Data

Data for 1957 are presented in Tables 3 and 4. Locations of the farms sampled are shown in Fig. 1. Sixty-seven samples were taken in The Dalles area on July 1-2 from 34 locations and 73 samples on October 2 from 40 locations. The average for the July 1-2 samples was 10.9 ppm fluorine with a range from 3.0 to 25.3 ppm. On October 2 the average was 9.7 ppm with a range from 0.1 to 23.5 ppm. Thirty-five of the 67 samples taken in July were above 10.0 ppm. Eighty per cent of the cherry samples contained more than 10.0 ppm while only 57% of the apricot samples exceeded this level.

Twenty-seven of the 73 samples taken in October contained 10.0 ppm fluorine or more. Sixty-one per cent of the cherry samples contained more than 10.0 ppm while about one-third of the apricot samples contained that amount of fluorine. Table 4 shows that the samples collected in July and in October, 1957 were similar in fluorine content. The samples collected at Corvallis were all below 10.0 ppm fluorine.

To determine whether or not there was a difference in the fluorine content of the samples from different sections of the area, radii were drawn from the factory to the west, southwest, south, southeast, and to the east. The average fluorine content for leaves of trees and grapes and for alfalfa in each of the four sections was determined. These results are presented in Table 5.

The average values for leaves of trees and grapes on July 1-2 ranged from 10.0 ppm in Section II to 14.1 ppm in Section III. Similar results for October 2 were 9.9 ppm in Section I and 11.5 ppm in Section III. These variations are small and indicate there were no substantial differences in the fluorine content of samples from the different sectors. Similarly, the fluorine content of alfalfa did not vary appreciably from one sector to another.

1958 Data

Data for 1958 are presented in Tables 6 and 7. At the first collection, June 30-July 1, all samples from The Dalles area averaged

6.9 ppm fluorine while those from Corvallis averaged 6.7 ppm. The range was from 3.1 to 39.7 ppm at The Dalles and 3.0 to 15.1 ppm at Corvallis. In October the average for all crops sampled in The Dalles was 68.1 ppm fluorine with a range from 16.3 to 197 ppm. The Corvallis check samples averaged 10.8 ppm in October. The aluminum factory at The Dalles was reported (6) to have started operations July 26, 1958.

The average fluorine content of all samples at approximately 1-mile intervals from 1-5 miles from the factory are presented in Table 8. These averages were all less than 10 ppm at the earlier sampling. In October the averages were: 0-1 mile, 140 ppm; 1-2 miles, 113 ppm; 2-3 miles, 55 ppm; 3-4 miles, 46 ppm; and 4-5 miles, 54 ppm.

Comparisons on a directional basis are not entirely satisfactory because samples of similar materials could not be collected at the same distance in all sections. The data presented in Table 9 show that a fairly high fluorine concentration was found 3-4 miles west of the factory (SW to NW sector) in October and that an appreciable concentration (66.9 ppm) was found at this time more than 5 miles east and southeast of the factory. All samples collected in October within 1 mile to the west averaged about 153 ppm while all samples between 1 and 2 miles to the south and southwest averaged about 136 ppm.

The highest concentration found in October (197 ppm) occurred at location 6 in leaves of cherry trees growing about 1 mile southwest of the factory. The next highest fluorine concentration was found in leaves of sour cherry trees growing on The Dalles Experimental Farm, Station No. 10, 1½ miles SSW of the factory. At this time alfalfa collected about 1 mile to the NW of the factory contained 179 ppm fluorine, and apricot and cherry leaves 4½ miles ESE averaged 103 ppm, while apricot and peach leaves about 1 mile SW of the factory averaged 176 ppm.

Although some of the fluorine concentrations found in some of the crops sampled in October approached 200 ppm, no leaf injury was noted on any of the samples collected. Adams (1) noted that apricot leaves containing 160 ppm showed no injury. However, leaves may be less susceptible to fluorine injury when exposed late in the growing season.

1959 Data

Leaf and forage samples were collected in 1959 on June 17 and August 27-28 from the orchards and fields previously sampled. The data on fluorine content are presented in Tables 10 and 11. All crops in The Dalles area averaged 26.4 ppm fluorine at the June 17 sampling and 73.4 ppm at the August 27 sampling. Comparable samples taken near Corvallis averaged 6.5 ppm and 10.3 ppm fluorine on June 19 and September 1 respectively. There was a wide range in the fluorine content of The Dalles samples--6.6 to 106 ppm on June 17 and 18.4 to 207 on August 27-28. The Corvallis samples all contained less than 10 ppm on June 19 and 20 ppm or less on September 1.

Fluorine content of samples collected at different distances and directions from the aluminum factory are shown in Table 12. These data indicate that in some instances the fluorine content of the samples

taken within a sector tended to decrease with distance from the factory while in other instances there were no noticeable trends. Data for a single crop, sweet cherries, tended to substantiate these observations. The fluorine content of cherry leaves taken in August from Station 6 at 1 mile was 140 ppm; from Station 13 at 2 miles, 86 ppm; and from Station 18A at 6 miles, 20 ppm. These stations are located to the southwest of the factory. On the other hand, Stations 31, 33, and 34 are located about 3.5, 4.25 and 5.25 miles to the ESE of the factory. Cherry leaves collected from these stations in August contained 172, 130 and 207 ppm fluorine respectively.

The average fluorine content of all samples at approximately 1-mile intervals from 1 to 6 miles from the factory are presented in Table 13. The effect of time of sampling is shown clearly--the earlier samples containing less than half as much fluorine as the later ones. There was a gradual decrease in fluorine content with distance from the factory from 0-1 mile to 3-4 miles in June, and from 1-2 to 3-4 miles in August. The fluorine content increased thereafter. Most of this increase beyond 3-4 miles was contributed by samples from stations in the E to SE sector. In this sector there were no sampling stations within 3 miles from the factory. See Table 10 and Fig. 1.

Leaf Scorch

Although marginal burn was not found on any of the samples collected in 1958, a small amount of marginal burn characteristic of fluoride scorch was found June 17, 1959 on apricot leaves taken from Stations 12 and 31. By August 27 leaf scorch was found in all apricot orchards at Stations 4, 6, 10, 11A, and 12. Leaf markings were slight on apricot leaves examined at Station 20. The injury in the 11A and 12 orchards was extremely variable, some trees showing no observable symptoms while other trees nearby and of the same variety showed severe marginal scorch. Prune leaves at Orchard 12 also showed moderate marginal scorch characteristic of fluorine injury. Scorched apricot and prune leaves taken from this orchard on July 19 contained 41.1 and 46.2 ppm fluorine respectively while normal-appearing non-scorched leaves from the same trees contained 35.5 and 33.6 ppm fluorine respectively.

Fluorine Content of Peach Fruits

In 1959 peach fruits collected from orchards in the Cherry Heights and lower Mill Creek areas showed a premature ripening and softening along the suture, the swelling often extending to the apex. This condition has been described and termed "soft suture" by Benson (2). A limited number of peach fruits were collected for fluorine analysis from orchards within about 2 miles of the factory. The data obtained are presented in Table 14. The fluorine contents of peach flesh from the suture side or blossom end are contrasted with those of tissue from the side opposite the suture. With one exception The Dalles samples contained more fluorine in the suture or blossom end tissue than in tissue from the opposite side of the peach. Although there appears to be a noticeable difference in the fluorine content of the two sides of the peach, the data are too limited to be conclusive.

Literature Cited

1. Adams, D. F. 1956. The effects of air pollution on plant life. A.M.A. Arch. Indust. Health 14:229-245.
2. Benson, Nels. 1959. Fluoride injury or soft suture and splitting of peaches. Proc. Amer. Soc. Hort. Sci. 74:184-198.
3. Compton, O. C. and L. F. Remmert. 1960. Effect of air-borne fluorine on injury and fluorine content of gladiolus leaves. Proc. Amer. Soc. Hort. Sci. 75:663-675.
4. Miller, V. L., Folke Johnson and D. F. Allmendinger. 1948. Fluorine analysis of Italian prune foliage affected by marginal scorch. Phytopath. 38:30-37.
5. Remmert, L. F. and T. D. Parks. 1953. Determination of fluorine in plant materials. Anal. Chem. 25:450-453.
6. Rochon, C. A., Chief Chemist, Harvey Aluminum Inc., The Dalles, April 27, 1959. Private communication.
7. Thomas, Moyer D. 1956. Air pollution handbook. Section 9. McGraw-Hill Book Co., Inc. New York.

Table 1. Fluorine content of foliage and forage samples,
The Dalles area, August 13-14, 1953.

Station No.	Farm	Crop	Fluorine Content, Dry Weight Basis ppm
1	Webb	Cherry*	14.4
2	Ellitt	Apricot	4.5
		Cherry	3.3
		Peach	1.2
		Prune	4.0
3	Patten	Prune	3.9
4	Cramer	Apricot	1.6
		Cherry	3.3
5	Erickson	Apricot	2.7
		Cherry	4.2
		Peach	2.9
6	Francois	Cherry	16.6
		Peach	4.9
7	Renslam	Alfalfa	2.5
		Apricot	2.5
		Cherry	4.2
		Grape	6.2
		Peach	5.6
8	Nielson	Apricot	5.0
		Cherry	5.3
		Cherry	7.1
		Grape	5.1
		Peach	5.0
9	Exp. Station	Apricot	6.8
		Cherry	16.8
		Cherry	7.6
		Grape	6.4
		Peach	16.7
10	Bailey	Apricot	2.6
		Sr. Cherry	7.4
		Cherry	16.3
		Peach	6.9
11	Curtis	Apricot	3.2
		Cherry	2.9
		Peach	4.4
12	Cooper	Apricot	5.5
		Cherry	5.4
13	Renkin	Sr. Cherry	4.1
		Cherry	6.2
14	Tibbetts	Sr. Cherry	3.8
		Cherry	3.6
		Peach	6.7
15	Martin	Alfalfa	8.9
		Apricot	12.0
		Cherry	8.5

*"Cherry" refers to sweet cherry. Sour cherry is so indicated.

Table 1 (con't). Fluorine content of foliage and forage samples,
The Dalles area, August 13-14, 1953.

Station No.	Farm	Crop	Fluorine Content, Dry Weight Basis ppm
16	Wagonblast	Alfalfa	3.6
17	Kaufman	Apricot	4.2
		Peach	5.1
18	Roberts	Sr. Cherry	10.8
		Cherry	8.7
		Peach	10.9
19	Geiger	Cherry	7.5
		Peach	7.9

Table 2. Fluorine content of foliage and forage samples,
average per crop, The Dalles area,
August 13-14, 1953.

Crop	Number of Samples	Fluorine Content, Dry Weight Basis	
		Range ppm	Average ppm
Alfalfa	3	2.5- 8.9	5.0
Apricot	11	1.6-12.0	4.6
Cherry	18	2.9-16.8	7.9
Sour Cherry	4	3.8-10.8	6.5
Grape	3	5.1- 6.4	5.9
Peach	12	1.2-16.7	6.5
Prune	2	3.9- 4.0	4.0

Total No. Samples-----53
Range, All Crops-----1.2-16.8 ppm F
Average, All Crops-----6.4 ppm F

Table 3. Fluorine content of foliage and forage samples,
The Dalles area, 1957.

Station No.	Farm	Crop	Fluorine Content, Dry Weight Basis	
			July 1-2 ppm	October 2 ppm
1	Wetle	Alfalfa	6.5	6.1
2	Wetle	Alfalfa	7.9	7.6
3	Stadelman	Alfalfa	5.9	9.3
4	Fleck	Apricots	25.3	16.1
		Peach	16.6	17.9
5	Herman (Church)	Alfalfa	5.2	4.8
6	Kroon	Apricot	6.9	8.4
		Cherry*	8.0	9.6
		Peach	5.4	7.5
7	Sinsibau	Alfalfa	5.1	1.7
8	Hertel	Cherry	15.8	10.9
		Peach	14.5	3.9
9	Fleck	Cherry	17.6	9.7
		Peach	8.3	6.3
10	The Dalles Exp. Farm	Apricot	14.2	13.9
		Sr. Cherry	14.5	23.5
		Cherry	13.8	19.6
		Peach	10.3	15.0
11	Meyer	Grape	14.0	8.4
12	Anderson	Apricot	5.9	7.5
		Peach	7.6	8.6
13	Malcom	Cherry	7.8	7.0
14	Williams	Cherry	10.1	6.4
		Prune	9.1	8.3
15	Francois	Peach	7.5	20.9
16	Davis	Apricot	9.4	9.3
		Cherry	12.5	10.4
17	Ed. Renslam	Alfalfa	3.0	--
		Apricot	5.1	5.2
		Cherry	9.4	4.7
		Grape	8.5	5.4
		Peach	7.8	5.8
18	Kortage	Alfalfa	4.7	9.6
19	Earl Renslam	Cherry	8.5	7.9
20	High Rolls Ranch	Apricot	8.4	9.4
		Peach	8.4	7.9
		Prune	7.0	11.3
21	Bailey	Cherry	14.6	11.8
		Sr. Cherry	22.1	13.0

* Cherry refers to sweet cherry. Sour cherry is so indicated.

Table 3 (con't). Fluorine content of foliage and forage samples,
The Dalles area, 1957.

Station No.	Farm	Crop	Fluorine Content, Dry Weight Basis	
			July 1-2 ppm	October 2 ppm
22	Curtis	Apricot	5.2	5.1
		Cherry	5.3	6.7
		Peach	4.0	5.7
22A	Curtis	Peach	---	9.7
23	Cooper	Alfalfa	12.3	8.8
		Apricot	13.9	5.6
		Cherry	13.8	10.4
24	Roberts	Cherry	14.3	12.8
		Sr. Cherry	14.9	7.4
		Peach	13.3	9.9
25	Martin	Alfalfa	9.0	5.3
		Apricot	10.4	7.8
		Cherry	11.6	5.8
		Sr. Cherry	13.1	16.8
26	Tibbetts	Cherry	13.1	13.9
		Sr. Cherry	10.1	4.7
27	Schantz	Cherry	16.1	15.9
27A	Kronberg	Cherry	---	14.7
28	Wagonblast	Alfalfa	3.9	0.1
29	Kaufman	Apricot	16.1	10.4
		Peach	18.3	14.5
30	Thompson	Cherry	18.1	16.6
31	Geiger	Apricot	11.8	10.5
		Cherry	17.7	5.3
		Peach	9.9	6.6
32	Johnson	Alfalfa	7.1	4.0
33	Cyphers Ranch	Apricot	12.5	10.9
		Cherry	11.4	12.0
34	Todd	Apricot	10.5	9.0
		Cherry	16.1	20.2
35 ⁺	Lewis-Brown Hort. Farm, Corvallis	Alfalfa	3.3	3.0
		Apricot	3.4	5.2
		Cherry	3.9	4.2
		Sr. Cherry	3.5	3.7
		Grape	4.6	8.6
		Peach	5.1	5.6
		Prune	4.3	5.7
36	Weeks	Alfalfa	---	8.0
		Cherry	---	15.1
37	Stadelman-Suefert	Apricot	---	8.2
38	Tenold	Cherry	---	13.4
39	Stadelman-Suefert	Alfalfa	---	5.5

⁺ Corvallis samples collected July 3 and October 5, 1957.

Table 4. Fluorine content of foliage and forage samples, average per crop, 1957.

Crop	Fluorine Content, Dry Weight Basis									
	No. of Samples		The Dalles				Corvallis*			
			July 1-2		October 2		July 3		Oct. 5	
	July	Oct.	Range	Average	Range	Average	Range	Average	Range	Average
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Alfalfa	11	12	3.0-12.3	6.4	0.1- 9.6	5.9	3.3	3.0		
Apricot	14	15	5.1-25.3	11.1	5.1-16.1	9.2	3.4	5.2		
Cherry	20	23	5.3-18.1	12.8	4.7-20.2	11.3	3.9	4.2		
Sour Cherry	5	5	10.1-22.1	14.9	4.7-23.5	11.1	3.5	3.7		
Grape	2	2	8.5-14.0	11.3	5.4- 8.4	6.9	4.6	8.6		
Peach	13	14	4.0-18.3	10.1	3.9-20.9	10.0	5.1	5.6		
Prune	2	2	7.0- 9.1	8.1	8.3-11.3	9.8	4.3	5.7		

* There was only one sample per crop at Corvallis.

Summary for The Dalles

	July 1-2	October 2
Total No. Samples	67	73
Range, All Crops, ppm	3.0-25.3	0.1-23.5
Average, All Crops, ppm	10.9	9.7

Table 5. Fluorine content of foliage of fruit trees, grape vines, and alfalfa forage; average for various sections of The Dalles area, 1957.

Section and Sampling Stations	Average Fluorine Content, Dry Weight Basis			
	Fruit Trees & Grapes		Alfalfa	
	July 1-2	Oct. 2	July 1-2	Oct. 2
	ppm	ppm	ppm	ppm
Section I Stations 1,2,4,5,6,7, 8,9,12,13 & 36 -----	11.6	9.9	6.2	5.6
Section II Stations 3,10,11,14,15, 16,17,18,19,20,21,22 & 22A --	10.0	10.2	4.5	9.5
Section III Stations 23,24,25,26, 27,27A,28,29 & 30 -----	14.1	11.5	8.4	4.7
Section IV Stations 31,32,33,34, 37,38 & 39 -----	12.8	10.7	7.1	4.8

Table 6. Fluorine content of foliage and forage samples,
The Dalles area, 1958.

Station No.	Farm	Crop	Fluorine Content, Dry Weight Basis	
			June 30- July 1 ppm	October 7-8 ppm
1	Wetle	Alfalfa	0.9	---
2	Wetle	Alfalfa	2.4	179.
3	Stadelman	Alfalfa	2.7	49.9
4	Fleck	Apricot	5.1	174.
		Peach	3.2	178.
5	Herman (Church)	Alfalfa	1.2	59.1
6	Kroon	Apricot	4.0	151.
		Cherry	3.1	197.
		Peach	8.2	134.
7	Sinsibau	Alfalfa	7.6	95.1
8	Hertel	Cherry	6.4	55.2
		Peach	4.0	91.4
9	Fleck	Cherry	11.1	95.5
		Peach	5.2	129.
10	The Dalles Exp. Farm	Apricot	7.1	143.
		Cherry	6.3	167.
		Sour Cherry	8.7	186.
		Peach	8.3	126.
		Prune	7.4	137.
11	Meyer	Grape	16.6	55.9
12	Anderson	Alfalfa	4.8	----
		Apricot	5.2	86.4
		Peach	7.8	48.2
		Prune	5.4	----
13	Malcom	Cherry	13.9	63.8
14	Williams	Cherry	9.5	29.4
15	Francois	Peach	10.8	51.6
16	Davis	Apricot	8.9	57.5
		Cherry	7.3	39.8
17	Renslam	Alfalfa	1.7	----
		Apricot	3.8	19.5
		Cherry	3.4	42.8
		Grape	3.6	19.1
		Peach	4.5	19.4
18	Kortage	Alfalfa	4.1	21.5
19	Renslam	Cherry	3.7	43.0
20	High Rolls Ranch	Apricot	3.1	27.8
		Peach	3.2	17.6
		Prune	17.4	37.8
21	Bailey	Cherry	9.3	53.5
		Sour Cherry	7.6	99.2
22	Curtis	Apricot	3.9	25.9
		Cherry	8.0	16.3
		Peach	8.0	16.5

Table 6 (con't). Fluorine content of foliage and forage samples,
The Dalles Area, 1958.

Station No.	Farm	Crop	Fluorine Content, Dry Weight Basis	
			June 30- July 1 ppm	October 7-8** ppm
22A	Curtis	Peach	39.7	67.6
23	Cooper	Alfalfa	23.5	29.8
		Apricot	32.2	47.8
		Cherry	9.5	47.6
24	Roberts	Alfalfa	3.5	----
		Cherry	4.9	49.3
		Sour Cherry	3.5	49.8
		Peach	4.3	31.6
25	Martin	Alfalfa	9.8	25.2
		Apricot	4.3	38.2
		Cherry	4.7	42.7
		Sour Cherry	3.0	29.5
26	Tibbetts	Cherry	4.7	33.0
		Sour Cherry	3.2	31.4
27	Schantz	Cherry	4.4	38.8
27A	Kronberg	Cherry	4.9	67.4
28	Wagonblast	Alfalfa	1.7	18.7
29	Kaufman	Peach	3.7	87.0
30	Thompson	Cherry	6.0	46.9
31	Geiger-Wilson	Apricot	4.2	72.2
		Cherry	5.1	63.7
		Peach	6.9	67.7
32	Johnson	Alfalfa	9.6	29.4
33	Cyphers	Apricot	3.5	107.
		Cherry	4.4	97.8
34	Todd	Apricot	3.8	54.3
		Cherry	3.9	78.6
36	Weeks	Alfalfa	4.7	----
		Cherry	7.3	52.9
37	Stadelman-Suefert	Apricot	4.7	32.6
38	Tenold	Cherry	6.5	67.8
39	Stadelman-Suefert	Alfalfa	5.9	22.2
35*	Lewis-Brown and Beach Farm, <u>Corvallis</u>	Alfalfa	4.9	7.8
		Apricot	15.1	12.1
		Cherry	7.8	13.0
		Sour Cherry	9.0	15.2
		Grape	3.9	7.7
		Peach	3.0	9.9
		Prune	3.1	10.0

* Corvallis samples collected July 3 and October 13, 1958.

** Aluminum factory at The Dalles started operations July 26, 1958 (6).

Table 7. Fluorine content of foliage and forage samples as the average per crop, 1958.

Crop	Fluorine Content, Dry Weight Basis									
	The Dalles					Corvallis*				
	No. of Samples		June 30-July 1		October 7-8		June 30-July 1		October 7-8	
	July 1	Oct. 7-8	Range	Average	ppm	Range	Average	ppm	Range	Average
Alfalfa	15	10	0.9-23.5	5.6	18.7-179.0	53.0	4.9	7.8		
Apricot	14	14	3.1-32.2	6.7	19.5-174.0	74.1	15.1	12.1		
Cherry	23	23	3.1-13.9	6.4	16.3-197.0	64.8	7.8	13.0		
Sour Cherry	5	5	3.0- 8.7	5.2	29.5-186.0	79.2	9.0	15.2		
Grape	2	2	3.6-16.6	10.1	19.1- 55.9	37.5	3.9	7.7		
Peach	14	14	3.2-39.7	8.4	16.5-178.0	76.1	3.0	9.9		
Prune	3	2	5.4-17.4	10.1	37.8-137.0	87.4	3.1	10.0		

* There was only one sample per crop at Corvallis.

Summary for The Dalles

	June 30-July 1	October 7-8
Total No. Samples	76	70
Range, All Crops, ppm	3.1-39.7	16.3-197.0
Average, All Crops, ppm	6.9	68.1

Table 8. Average fluorine content of 7 crops.
The Dalles.

Distance From Factory miles	June 30, 1958 Before Factory in Operation ppm	Oct. 7, 1958 After Factory in Operation 73 Days ppm
0-1	3	140
1-2	8	113
2-3	6	55
3-4	9	46
4-5	4	54

Aluminum factory at The Dalles started operations
July 26, 1958 (6).

Table 10. Fluorine content of foliage and forage samples,
The Dalles area, 1959.

Station No.	Farm	Crop	Fluorine Content, Dry Weight Basis	
			June 17 ppm	August 27-28 ppm
1	Wetle	Alfalfa	26.6	----
2	Wetle	Alfalfa	31.5	74.3
3	Stadelman	Alfalfa	17.0	26.0
4	Fleck	Apricot	106.	83.5
		Peach	47.0	77.8
		Prune	62.0	120.
5	Herman (Church)	Alfalfa	26.9	63.2
6	Kroon	Apricot	36.7	135.
		Cherry	48.4	140.
		Peach	28.1	100.
7	Sinsibau	Alfalfa	21.3	43.6
7A	Daniels	Prune	22.2	136.
8	Hertel	Cherry	26.5	75.2
		Peach	22.0	47.6
9	Fleck	Cherry	27.6	71.0
		Peach	24.6	98.4
		Alfalfa	----	39.9
10	The Dalles Exp. Farm	Apricot	28.9	115.
		Cherry	50.2	118.
		Sour Cherry	37.6	133.
		Peach	31.6	95.8
		Prune	30.9	127.
11	Meyer	Grape	18.6	78.3
11A	Bunn	Apricot	----	110.
12	Anderson	Alfalfa	----	----
		Apricot	25.3	45.3
		Peach	23.1	63.0
		Prune	----	60.0
13	Malcom	Cherry	28.9	85.9
14	Williams	Cherry	23.1	85.6
15	Francois	Peach	17.6	88.5
16	Davis	Apricot	15.9	63.6
		Cherry	20.7	51.1
16A	Curtis Bros.	Sour Cherry	----	53.7
17	Renslam	Alfalfa	9.6	18.4
		Apricot	8.1	43.7
		Cherry	17.0	38.0
		Grape	12.6	31.1
		Peach	8.4	32.0
18	Kortage	Alfalfa	7.5	26.0
18A	J. Martin	Cherry	12.6	20.4

Table 10 (con't). Fluorine content of foliage and forage samples,
The Dalles area, 1959.

Station No.	Farm	Crop	Fluorine Content, Dry Weight Basis	
			June 17 ppm	August 27-28 ppm
19	Renslam	Cherry	17.1	60.0
20	High Rolls Ranch	Apricot	11.3	22.8
		Peach	14.1	31.5
		Prune	24.5	44.1
21		Bailey	Cherry	14.4
		Sour Cherry	16.2	42.2
22	Curtis	Apricot	7.5	21.2
		Cherry	8.7	26.7
		Peach	6.6	25.0
22A	Curtis	Peach	9.3	46.7
23	Cooper	Alfalfa	16.6	34.3
		Apricot	19.9	47.8
		Cherry	26.6	108.
24	Roberts	Alfalfa	----	----
		Cherry	31.0	146.
		Sour Cherry	21.2	78.3
		Peach	29.1	95.1
25	Martin	Alfalfa	11.0	22.9
		Apricot	20.9	----
		Cherry	20.4	75.1
		Sour Cherry	15.2	68.9
26	Tibbetts (Sander Bros.)	Cherry	17.1	53.0
		Sour Cherry	16.2	56.3
27		Schantz	Cherry	21.8
27A	Kronberg	Cherry	15.6	39.4
28	Wagonblast	Alfalfa	9.1	27.0
29	Kaufman	Peach	21.6	83.8
30	Thompson	Cherry	28.6	132.
31	Geiger-Wilson	Apricot	56.2	139.
		Cherry	56.3	172.
		Peach	32.0	95.4
32	Johnson	Alfalfa	38.3	67.2
33	Cyphers	Apricot	91.3	148.
		Cherry	64.8	130.
34	Todd	Apricot	34.7	91.6
		Cherry	53.7	207.
36	Weeks	Alfalfa	7.2	20.8
		Cherry	14.9	44.7
37	Stadelman-Suefert	Apricot	28.6	45.3
38	Tenold	Cherry	40.5	84.7
39	Stadelman-Suefert	Alfalfa	16.4	22.9
40*	Klindt	Ginkgo	----	555.
		Maple	----	1005.

Table 10 (con't). Fluorine content of foliage and forage samples,
The Dalles area, 1959.

Station No.	Farm	Crop	Fluorine Content, Dry Weight Basis	
			June 17 ppm	August 27-28 ppm
35**	Lewis-Brown and Beach Farm, <u>Corvallis</u>	Alfalfa	3.9	3.8
		Apricot	6.1	8.0
		Cherry	6.6	10.3
		Sour Cherry	7.8	7.4
		Grape	8.5	9.8
		Peach	6.3	12.5
		Prune	6.6	20.0

* About one-fourth mile NE of the aluminum factory.

** Corvallis samples collected June 19 and September 1, 1959.

Table 11. Fluorine content of foliage and forage samples as the average per crop, 1959

Crop	No. of Samples		Fluorine content, dry weight basis						Corvallis*	
			The Dalles			August 27-28			June 19	Sept. 1
	June 17	Aug. 27-28	June 17		August 27-28		Average		ppm	ppm
			Range	Average	Range	Average	ppm	ppm	ppm	ppm
Alfalfa	13	13	7.2 - 38.3	18.4	18.4 - 74.3	37.4	3.9	3.8	3.8	
Apricot	14	14	7.5 - 106.	35.1	21.2 - 148.	79.4	6.1	8.0	8.0	
Cherry	24	24	8.7 - 64.8	28.6	20.4 - 207.	88.1	6.6	10.3	10.3	
Sour Cherry	5	6	15.2 - 37.6	21.3	42.2 - 133.	72.1	7.8	7.4	7.4	
Grape	2	2	12.6 - 18.6	15.6	31.1 - 78.3	54.7	8.5	9.8	9.8	
Peach	14	14	6.6 - 47.0	22.5	25.0 - 100.	70.0	6.3	12.5	12.5	
Prune	4	5	22.2 - 62.0	34.9	44.1 - 136.	97.4	6.6	20.0	20.0	

Summary for the Dalles

Total No. of Samples	June 17	August 27-28
Range, all crops, ppm	76	78
Average, all crops, ppm	6.6 - 106.	18.4 - 207.**
	26.4	73.4 **

*There was only one sample per crop at Corvallis.

**Data for ginkgo and maple leaves were excluded.

Table 12. Fluorine content of foliage and forage samples as the average for all crops at different distances and directions from the aluminum factory at The Dalles, 1959.

Distance From Factory miles	Average fluorine content, dry weight basis											
	N to NW		W to SW		SW to S		S to SE		SE to E			
	June 17 ppm	Aug. 27 ppm	June 17 ppm	Aug. 27 ppm	June 17 ppm	Aug. 27 ppm	June 17 ppm	Aug. 27 ppm	June 17 ppm	Aug. 27 ppm		
0 - 1	29.5	74.3	50.7	102.8	17.0	26.0	-----	-----	-----	-----	-----	
1 - 2	-----	-----	25.8	63.6	33.0	111.0	-----	-----	-----	-----	-----	
2 - 3	11.5	32.8	23.0	75.6	19.3	78.0	27.1	106.5	-----	-----	-----	
3 - 4	-----	-----	26.1	69.8	12.8	38.3	18.7	59.5	45.7	118.4	-----	
4 - 5	-----	-----	-----	-----	7.5	26.0	18.6	69.0	50.3	86.6	-----	
5 - 6	-----	-----	-----	-----	12.6	20.4	-----	-----	43.0	127.8	-----	

Table 13. Average fluorine content of
7 crops grown at different distances
from the factory, 1959.

Distance From Factory miles	Fluorine Content, Dry Weight Basis	
	June 17 ppm	August 27 ppm
0 - 1	43.0	91.1
1 - 2	30.6	93.6
2 - 3	21.1	76.8
3 - 4	19.7	56.4
4 - 5	28.2	71.3
5 - 6	35.4	100.9

Table 14. Fluorine content of portions of peach fruits showing "soft suture," 1959.

Farm	Variety	Dates Sampled	Fluorine Content, Dry Weight Basis	
			Suture Side ppm	Side Opposite Suture at Stem End ppm
The Dalles Exp. Farm. #10	Red Haven	Aug. 18	7.2	6.6
	Red Haven	"	7.5*	8.1
Hood River Exp. Station, Hood River	Red Haven	Aug. 18	4.3	6.8
	Red Haven	"	3.2*	3.1
The Dalles Exp. Farm. No. 10	J. H. Hale	Aug. 18	7.1	4.7
Bunn #11A	J. H. Hale	Aug. 18	10.2	7.0
The Dalles Exp. Farm. No. 10	E. Crawford	Aug. 27	21.9	7.1
High Rolls No. 20	Elberta	Aug. 27	9.9	4.9
	J. H. Hale	"	10.2	6.0
Fleck No. 4	J. H. Hale	Aug. 27	11.0	7.9
Williams No. 14	J. H. Hale	Aug. 27	14.5	4.4

* Blossom end

Table 15. Range and average leaf fluorine contents of 7 crops, The Dalles.

Date Sampled	No. Samples	Fluorine Content, Dry Weight Basis	
		Range ppm	Average ppm
Aug. 13, 1953	53	1-17	6
July 1, 1957	67	3-25	11
Oct. 2, 1957	73	0.1-24	10
June 30, 1958	76	3-40	7
Oct. 7, 1958	70	16-197*	68*
June 17, 1959	76	6-106	26
Aug. 27-28, 1959	78	18-207	73

* Aluminum factory started operating July 26, 1958 (6).